Protection of building columns against car impact

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Abstract

With the rapid growth in the number of infrastructure projects, the collision of vehicles with structures has increased significantly in recent decades. The structural column that is subjected to impact force imposed by a vehicle travelling at high speed may be damaged severely and lost its designed strength which can lead to failure in the column. In the worst case, the failure of the column can lead to a progressive collapse of the building. On the other hand, the provisions of the current codes of practice are not providing enough safety in case of a collision between veered vehicle and a particular column. Therefore, it is necessary to provide extra measures to protect the columns from car impact. One of the measures is to provide a protective barrier around the columns which are exposed to the potential impact.

The purpose of this study was to develop a protective barrier to protect the columns located in parking garages from car impact. The proposed system is a stiffened-steel-plates barrier and it is composed of an inner steel sheet surrounding the column, an outer steel sheet and stiffeners with a specific arrangement between the two steel sheets. The protection systems with three different geometry were developed to surround square, rectangular and circular columns. The study also aimed to investigate numerically the effect of different configurations, and geometrical parameters to optimize the size of the barrier. Therefore, finite element (numerical) models of the proposed protective systems were developed using LS-DYNA software. The numerical models were validated using existing experimental data.

Another purpose of the study was to provide a design guideline for the developed protective barrier using the parametric study of the finite element (FE) model and evaluate the performance of the proposed protection systems. Therefore, FE parametric studies were conducted in the third part of this research. The parametric studies were intended to evaluate the effect of the plate’s thickness, the yield stress of the steel sheets, the stiffeners’ thickness and the impact velocity.

From the FE analysis and parametric study, it can be concluded that the developed protection systems are capable to stop the impacting vehicle (maximum velocity 35km/h) with a deformation of the outer sheet, which is less than the gap provided between the inner and outer sheets. In addition, the average impact forces that are transmitted to the RC columns are less than the maximum transverse equivalent static force recommended by EN 1991-1-7 (2006) for designing the RC columns that are located in parking garages.